Article

Incidence of post-anesthetic colic in non-fasted adult equine patients

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Abstract — The purpose of this study was to determine the incidence of post-anesthetic colic in non-fasted adult horses undergoing isoflurane inhalant anesthesia for an elective, non-abdominal procedure at a single referral center. Medical records were searched from May 1, 2012 to May 31, 2014. Inclusion criteria included non-fasted patients ≥ 2 years of age that were anesthetized for an elective, non-abdominal procedure. The incidence of post-anesthetic colic for this study population was 2.5%. None of the risk factors examined (season, age, gender, breed, surgeon, procedure, recumbency, butorphanol administration, additional surgical complications, and the length of anesthesia) were associated with an increased risk of post-anesthetic colic. Providing food may maintain normal gastrointestinal motility and may decrease the risk of post-anesthetic colic.

Résumé — Incidence des coliques post-anesthésiques chez des patients équins adultes sans jeûne. Le but de cette étude consistait à déterminer l'incidence des coliques post-anesthésiques chez des chevaux adultes sans jeûne soumis à une anesthésie par inhalation d'isoflurane pour une intervention non abdominale non urgente dans un seul centre spécialisé. On a effectué des recherches dans les dossiers médicaux établis entre le 1er mai 2012 et le 31 mai 2014. Les critères d'inclusion incluaient les patients sans jeûne âgés de ≥ 2 ans qui avaient été anesthésiés pour une intervention non abdominale et non urgente. L'incidence des coliques post-anesthésiques pour cette population à l'étude a été de 2,5 %. Aucun des facteurs de risque examinés (saison, âge, sexe, race, chirurgien, intervention, décubitus, administration du butorphanol, complications chirurgicales additionnelles et durée de l'anesthésie) n'était associé à un risque accru de coliques post-anesthésiques. La nourriture peut préserver la motilité gastro-intestinale et réduire le risque de coliques post-anesthésiques.

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Introduction

General anesthesia in horses has been associated with severe complications such as death, fractured limbs, and colic. Post-anesthetic colic increases the morbidity, mortality, and expense associated with general anesthesia. Post-anesthetic colic rate has been reported from 2.8% to 10.5% in horses after an elective procedure and has been reported as high as 12% in horses undergoing elective and emergency procedures (1–6). Potential risk factors have been previously examined and many have been considered questionable, such as isoflurane use and the length of anesthesia (1,4,5).

Fasting equine patients prior to general anesthesia is common in some practices in an attempt to decrease the risk of post-anesthetic colic. Anesthetic protocols recommend fasting from 6 to 12 h before induction of anesthesia (1–6). Most patients in previously published post-anesthetic colic studies were fasted before anesthesia (1–6). To the authors' knowledge, the incidence of post-anesthetic colic in a large population of equine patients allowed access to food prior to anesthesia has not been investigated.

The objective of this study was to determine the incidence of post-anesthetic colic in non-fasted adult horses undergoing isoflurane inhalant anesthesia for elective, non-abdominal procedures at a single, multi-surgeon referral center. We hypothesized that the incidence of post-anesthetic colic would be lower in a population of non-fasted horses compared to previously published incidence reports in fasted horses.

Materials and methods

Study design

Medical records at the referral center were searched for all horses that had undergone inhalant anesthesia including magnetic resonance imaging (MRI), from May 1, 2012 to May 31, 2014.

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A total of 1965 inhalant anesthetic procedures were performed during the 2-year period selected. Inclusion criteria consisted of patients ≥ 2 y of age, an elective-based procedure only, non-abdominal in nature, and the patients could not have been fasted before induction of general anesthesia. The patients had to be monitored in the hospital for a minimum of 24 h following isoflurane anesthesia. Patients were either in the hospital or returned for treatment of colic signs. Cases were excluded if the patient's age was unknown or if the horse was admitted to the hospital as an emergency. If horses had more than 1 general anesthetic procedure, each anesthetic event was included separately if the procedures were not performed within a 24-hour period. If a patient received 2 general anesthetics within a 24-hour period it was considered 1 procedure. This resulted in 1200 cases available for inclusion in the study.

Data collection

Data obtained from the medical records included date of the procedure, signalment (age, gender, and breed), procedure performed, recumbency, duration of hospitalization, if perioperative/intraoperative butorphanol was administered, the presence of any complications (gastrointestinal or otherwise), duration of anesthesia, and the surgeon performing the procedure. For cases showing signs of colic after surgery additional information collected included time to the first colic clinical signs, time to colic resolution, treatment type (medical, surgical, or other), treatment specifics, etiology if identified, and estimate of the additional cost due to colic treatment.

Horse management

The patients were presented the day before or the day of general anesthesia. Hospitalized patients received a standard diet of Bermuda grass hay and all-stock pelleted grain twice daily along with access to free choice water. Clients were instructed not to withhold feed, hay, or water from patients prior to anesthesia. Hospitalized patients received a minimum of once daily physical examination and visual examinations a minimum of 3 times daily.

Anesthesia

Anesthetic protocols are standardized within the surgical center. Horses undergoing elective procedures typically receive xylazine (Anased; Lloyd, Shenandoah, Iowa, USA), 0.7 mg/kg body weight (BW), IV, phenylbutazone (ButaJect; Henry Schein, Dublin, Ohio, USA), 4.4 mg/kg BW, IV, gentamicin (Gentafuse; Henry Schein), 6.7 mg/kg BW, IV, and procaine penicillin G (Pen-Aqueous; Aspen Veterinary Resources, Liberty, Missouri, USA), 20 000 IU/kg BW, IM, before surgery. Magnetic resonance imaging pre-anesthetic protocol differs as no pre-anesthetic non-steroidal anti-inflammatories or antimicrobials are administered. Induction is accomplished using diazepam (Hospira, Lake Forest, Illinois, USA), 0.11 mg/kg BW, IV, and ketamine (Ketaject; Phoenix, St. Joseph, Missouri, USA), 2.2 mg/kg BW, IV. Following induction, horses are maintained on isoflurane (Isothesia; Henry Schein) vaporized in 100% oxygen. Lactated Ringer's solution (Hospira) is administered IV. Patients receive dobutamine (Hospira) and calcium gluconate (Aspen Veterinary Resources, Liberty, Missouri, USA) infusion as needed to maintain mean arterial blood pressure above 60 mmHg. Butorphanol (Dorolex; Merck Animal Health, Summit, New Jersey, USA), 0.05 to 0.1 mg/kg BW, IV, is administered when necessary for painful procedures. Anesthetic time is recorded from the initiation of inhalation anesthesia to the end of inhalation anesthesia. Anesthetic monitoring includes direct arterial blood pressure via arterial catheter and electrocardiogram (Escort Prism; Medical Data Eletronics, Arleta, California, USA).

Case definition

A horse with colic was defined as one that required treatment for gastrointestinal discomfort. Clinical signs that indicated abdominal discomfort included pawing, rolling, inappetence, anorexia, lying down, or flank watching. If gastrointestinal discomfort was identified, a full physical examination was performed and the patient was treated as per the discretion of the attending surgeon.

Statistical analysis

A Chi-square (or Fisher Exact) test was used to identify possible risk factors associated with the likelihood of colic occurring following general anesthesia. Risk factors examined included season, age, gender, breed, surgeon, procedure, recumbency, butorphanol, additional surgical complications (including incisional dehiscence, post-operative myositis, colitis, and septic arthritis), and the duration of anesthesia. Age of the horse was categorized as young adult, mature adult, or geriatric. Duration of anesthesia was divided into long (≥ 60 min) or short (< 60 min). These classifications were based on Little et al (5).

Results

The incidence rate for post-anesthetic colic was 2.5% (30/1200). None of the risk factors examined (season, age, gender, breed, surgeon, procedure, recumbency, butorphanol administration, additional surgical complications, and the duration of anesthesia) were associated with a significantly increased risk of post-anesthetic colic (P = 0.21 to 1.0).

The season of the year had no influence on the number of colic cases *versus* non-colic cases seen in our study population. The age range of anesthetic patients that did not experience post-anesthesia colic was 2 to 23 y with a median age of 4 y. The age range of colic cases was also 2 to 23 y with a median age of 3.5 y. The non-colic cases included 606 geldings, 426 mares, and 117 stallions. Colic cases included 13 geldings, 14 mares, and 3 stallions. The most common breed affected by post-anesthetic colic was the Quarter Horse, followed by Thoroughbreds, which was consistent with the general population seen at the referral center. Butorphanol was administered to a total of 221 patients, 5 of which developed post-anesthetic colic.

The procedures performed under general anesthesia in the post-anesthetic colic cases included arthroscopy, conjunctival flap, third metacarpal bone fracture repair, MRI, plantar fasciotomy and neurectomy, superior check ligament desmotomy, cryptorchid castration, pastern arthrodesis, and wound repair. The general surgery caseload encompassed wide varieties of

anesthetic procedures with the most common procedures being orthopedic, upper respiratory, and MRI. Most anesthetic patients were in dorsal recumbency for the procedure. Average duration of anesthesia for non-colic surgical patients was 73.1 min and for post-anesthetic colic cases was 76.3 min; the range for all anesthetic procedures was 20 to 190 min.

Time until first observation of clinical signs of colic ranged from the same day of the anesthetic procedure to 6 d after surgery; any patients that experienced colic beyond 6 d after surgery were excluded as the anesthetic event was presumed to be unlikely to be the cause. The majority of patients (83.3%) exhibited colic signs within the first 48 h after surgery. An etiology was not identified in most colic cases (19 of 30 cases) but the most common etiology identified was large colon impaction (5 of 30 cases). Medical therapy alone was used to treat 28 of the 30 colic cases. Nasogastric intubation with administration of a mild laxative (Laxade Powder; Aspen Veterinary Resources, Liberty, Missouri, USA) and/or electrolyte powder (EntrolyteH.E; Pfizer, New York, New York, USA) was performed in 93.3% of the cases. For the other 2 colic cases that required additional therapy; one had a nephrosplenic entrapment correction procedure (rolling) performed and the other required an exploratory laparotomy. Rolling for nephrosplenic entrapment correction was successful after 1 attempt. The patient that required surgical intervention was diagnosed with a severe large colon impaction which was treated with a pelvic flexure enterotomy. This patient was euthanized 11 d following exploratory laparotomy due to post-operative complications related to the exploratory laparotomy, and not general anesthesia.

Discussion

In this study the incidence of post-anesthetic colic in adult, non-fasted horses undergoing an elective, non-abdominal procedure with general anesthesia was 2.5%, which is lower than in published reports (1–6). In these published reports, most of the patients were fasted for a minimum of 6 to 12 h before induction of anesthesia (1–6). Horses herein were allowed a normal diet and feeding regimen in the pre-anesthetic period, which is markedly different than the previously published studies examining post-anesthetic colic in equine patients.

Jago et al (6) investigated perianesthetic complications in an equine referral hospital and the most common complication was post-anesthetic colic. The population in that study (6) was similar to the current population as both had a large number of cases, a single referral hospital was involved, and similar anesthetic protocols were used. The major differences between the populations were fasting protocols, antimicrobials selected, surgical facility, and geographical location. Horses were fasted overnight before anesthesia was induced in the study published by Jago et al (6), as in the other previously published studies. Out of 1067 horses, 111 displayed signs of gastrointestinal pain with an incidence rate of 10.5%. The study by Jago et al (6) demonstrates that there is significant need to formulate recommendations to decrease post-anesthetic colic risk, as it is the most common post-operative complication encountered by the equine patient, accounting for 65% of the complications experienced in their study population.

Due to the retrospective nature of our study, there was no in-house control population of fasted patients available, due to hospital protocols, to directly compare non-fasted *versus* fasted patients under the same management protocols. The ideal situation to further investigate the role of fasting on post-anesthetic colic would be to perform a prospective randomized blinded control trial. As general anesthesia in the equine patient can be associated with a significant risk of morbidity and mortality, all steps should be taken to decrease the risk to the patient.

Another limitation of this study was consideration and investigation into other potential variables not examined. The potential risk factors examined were selected based on previous study findings as these had historical importance (1–6). One variable not specifically investigated was duration of preoperative hospitalization on the risk of post-anesthetic colic. This was not included as most horses were presented less than 24 h before surgery, which did not allow for an accurate comparison. Other potential risk factors not examined included the possible effect of certain antimicrobials administered or possible abnormalities on pre-anesthetic blood analysis. The standardized anesthetic protocol at this referral hospital involved the same broad-spectrum antimicrobial medication and pre-anesthetic blood analysis was not routinely performed.

Horses included in the current study were within the practice area and surgeons had regular communications with the referring veterinarians. All surgical complications were referred to the hospital for assessment and treatment including post-operative colic, ensuring a reliable incidence rate was determined. Anesthetic events were included separately if they occurred at least 24 h apart. Thirty-nine patients had 2 separate anesthetic procedures performed within 7 d. If the incidence rate was adjusted to only include anesthetic events separately if they occurred at least 7 days apart, the incidence is 30 out of 1161 cases or 2.58%, which remains markedly lower than that of previous studies.

It is important to understand the basis for the initial fasting recommendations before creating new recommendations. Reasons for fasting an equine anesthetic patient include reducing the risk of post-anesthetic colic, aspiration pneumonia, and hypoventilation (1–10). Regurgitation under general anesthesia rarely occurs in normal horses (7). In human, feline, and canine patients, fasting before general anesthesia was thought to reduce the risk of regurgitation and/or aspiration pneumonia (8,9). However, food deprivation has been linked to an increase in the volume and acidity of stomach contents, thus increasing the risk of regurgitation, aspiration pneumonia, and esophageal stricture in dogs (8). If regurgitation does occur in the equine patient it usually is associated with an indwelling nasogastric tube and manipulation of the stomach during colic surgery, not with procedures such as arthroscopy (7). However it is important to note that none of the patients in this study experienced complications associated with aspiration pneumonia or had evidence of regurgitation under or following general anesthesia.

Another reason many anesthetic protocols include a mandatory fast in equine patients is to decrease the size of the large colon, thus decreasing the pressure placed on the diaphragm to decrease the risk of hypoventilation. In ruminants, fasting

does not appear to be effective in reducing the risk of hypoventilation despite recommendations for a much longer fast (10). Considering that a 48-hour fast in ruminants does not decrease the size of the rumen enough to prevent hypoventilation, then the 6- to 12-hour fast in equine patients may also be ineffective in preventing hypoventilation (10). The direct effect of allowing access to feed on the ability to properly ventilate the patient during inhalant anesthetic procedures was not examined in this study, since arterial blood gas analysis was not performed at the surgical facility.

This study demonstrated a low risk of post-anesthetic colic in a large population of horses when food was not withheld. It may be important to understand the potential reason that fasting the equine anesthetic patient may increase the risk of post-anesthetic colic. Fasting in the equine patient may cause abnormal physiologic events to occur, leading to an increased risk of post-anesthetic colic. During a prolonged fast, myoelectric activity is decreased in the equine colon leading to a decrease in contractile activity (12). This decreased contractility may lead to an increase in transit time, allowing for impaction and gas build-up within the intestinal lumen leading to colic.

In addition to decreasing myoelectrical and contractile activity, fasting the equine patient also leads to a decrease in water intake. Horses restrict their food intake when water is restricted and conversely restrict water intake when food is restricted (14). A documented risk factor for colic is decreased water intake in normal, healthy horses (14,15). For anesthesia patients, maintaining access to food will likely ensure water intake is maintained, decreasing the risk of colic.

The risk of post-anesthetic colic in this population was low; however, possible causes for post-anesthetic colic in the fasted horse should be investigated in hopes of creating additional recommendations for patient management. The potential causes for post-anesthetic colic in non-fasted horses include change in management and stress associated with transportation and hospitalization. Williams et al (16) demonstrated that water intake and fecal water content showed an abrupt, significant change immediately following a change in management in horses that were moved from a pasture to a stabled environment (16). Stabled horses had a dramatic increase in water intake but produced less fecal water. This proves equine patients experience physiological effects when undergoing stressful events, such as being hospitalized (16). Patient husbandry was not recorded in the current study so the possible link between post-anesthetic colic and the management change from pasture to hospital could not be investigated.

This study suggests that non-fasted adult equine anesthetic patients have a decreased risk of post-anesthetic colic. Allowing equine patients access to free choice food and water before anesthesia may maintain normal myoelectrical and contractile intestinal activity. Fasting the equine anesthetic patient may predispose them to post-anesthesia colic. Additional studies are required to further investigate this topic, but this paper suggests the need to re-evaluate some of the current pre-anesthetic recommendations.

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